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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

Application Number: 10/509,935
Filing Date: August 19, 2005
Appellant(s): SARICIFTCI ET AL.

Sean P. Daley
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 3/31/2009 and supplemental appeal brief filed 4/27/2009 appealing from the Final Office action mailed 3/5/2009.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

Cravino, A. and Sariciftci, N.S. "Double-cable polymers for fullerene based organic optoelectronic applications" J. Mater. Chem., vol.12 (May 16, 2002) 1931-1943.

Sentein, C., Fiorini, C., Lorin, A., Sicot, L. and Nunzi, J-M. "Study of orientation induced molecular rectification in polymer films" Optical Materials, vol.9, (1998) pp. 316-322

Zhao, Y., Yuan, G. and Roche, P., "A calorimetric study of the phase transitions in poly(3-hexylthiophene)" vol.36, no. 11 (1995) 2211-2214.

Dittmer, J.J., Marseglia, E.A. and Friend, R.H. "Electron trappins in dye/polymer blend photovoltaic cells" Adv. Mater., vol.12, no. 17, (Sept. 1, 2000), 1270-1274.

Gebeyehu, D., Padinger, F., Brabec, C.J., Fromherz, T., Hummelen, J.C. and Sariciftci, N.S. "Characterization of large area flexible plastic solar cells based on conjugated polymer/fullerene composites, International J. of Photoenergy, vol. 1, (1999), pp. 1-5.

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claims 1-10, 12-19 and 22-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cravino (as cited in the IDS) in view of Sentein (as cited in the IDS) and in view of Zhao (as cited in the IDS) with supporting evidence provided by Dittmer (*Electron Trapping in Dye/Polymer Blend Photovoltaic Cells*) and further in view of Gebeyehu (*Characterization of large area flexible plastic solar cells based on conjugated polymer/fullerene composites*).

As to claims 1, 10, 19 and 24, Cravino teaches a photovoltaic cell comprising,

- A photoactive region and two metal electrodes (p-type/n-type between anode and cathode, Figure 1),

- The photoactive layer comprising a conjugated polymer component (electron donor) and a fullerene component (electron acceptor) (section 5, ¶ 1), and
- The two metal electrodes provided on either side of the photoactive layer (p- type/n-type between anode and cathode, Figure 1).

Cravino is silent to a method for the post treatment of a photovoltaic cell comprising:

- Subjecting the photovoltaic cell to heat treatment above a glass transition temperature of the conjugated polymer for a predetermined treatment time,
- The heat treatment of the photovoltaic cell being carried out for at least a portion of the treatment time under the influence of an electric field induced by a field voltage applied to the electrodes of the photovoltaic cell and exceeding a no-load voltage thereof.

Sentein teaches a method for the post treatment of a photovoltaic cell comprising:

- Subjecting the photovoltaic cell to heat treatment near a glass transition temperature of the conjugated polymer for a predetermined treatment time (section 1, ¶ 2),
- The heat treatment of the photovoltaic cell being carried out for at least a portion of the treatment time under the influence of an electric field induced by a field voltage applied to the electrodes of the photovoltaic cell

and exceeding a no-load voltage thereof (section 1, ¶ 2; section 5, ¶ 1).

Where 5 to 10 V clearly exceeds a no-load voltage.

It would have been obvious to one of ordinary skill in the art at the time of the invention to use the fullerene/polymer system of Sentein in Carvino because fullerenes have an extended delocalized π-electron source and lead to the cost effective fabrication of flexible large area solar cells, as taught by Sentein (section 1, ¶ 1).

Neither Cravino nor Sentein teach the heat treatment being above a glass transition temperature of the conjugated polymer.

Zhao teaches a heat treatment being above a glass transition temperature (Tg) of the conjugated polymer (Results section, ¶ 1).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Cravino and Sentein by increasing the heating temperature to above the T_g of the conjugated polymer as taught by Zhao because an enhanced crystallization of the polymer can be obtained, as taught by Zhao (Results section, ¶ 4), along with this enhanced crystallization comes increases in hole mobility as seen by the supporting evidence provided by Dittmer (page 1273, ¶ 1).

Cravino, Sentein and Zhao are silent to the conjugated polymer (donor) and fullerene (acceptor) being different compounds.

Gebeyehu teaches the use of conjugated polymer and fullerene composites which are favorably tuned by an electric field (section I, ¶ 4 and section 2, ¶3).

It would have been obvious to one of ordinary skill in the art at the time of the invention to use the separate fullerene (acceptor) and conjugated polymer (donor) of

Gebeyehu in modified Cravino because these systems are based on ultrafast, reversible, metastable photoinduced electron transfer and charge separation, as taught by Gebeyehu (abstract).

Further regarding claim 19, neither Cravino nor Sentein explicitly teach that the invention is subjected for between 2 and 8 min (claim 19); to heat treatment under the influence of an electric field.

It would have been obvious to one of ordinary skill in the art at the time of the invention to have subjected the cell to heat treatment for between 2 and 8 minutes (claim 19) since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F. 2d 272,205 USPQ 215 (CCPA 1980), especially in light of the fact that the time scale used during experimentation is of the same order of magnitude (min) as seen in Sentein (Figure 6) and as seen in Zhao (10 min) (experimental, ¶ 1).

Further regarding claim 24, the reference teaches simultaneously injecting charge carriers into the photovoltaic cell via at least one electrode selected from the group consisting of the first and second electrode. Application of the field will inherently, inject charge carriers.

Regarding claim 2, modified Cravino teaches that the electric field is induced via a field voltage that exceeds the no-load voltage of the photovoltaic cell by at least 1 V (Sentien: section 5, ¶ 1). Where 5 to 10 V clearly exceeds a no-load voltage.

Regarding claim 3, neither Cravino nor Sentein explicitly teach application of a field voltage between 2.5 and 3 V.

It would have been obvious to one of ordinary skill in the art at the time of the invention to apply a voltage between 2.5 and 3 V, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F. 2d 272,205 USPQ 215 (CCPA 1980), especially in light of the fact that the current/voltage experiments were performed for a broad range of values as seen in Sentein (Figure 5).

Regarding claim 4-9, neither Cravino nor Sentein explicitly teach that the invention as to claim 1 or claim 2 or claim 3 is subjected for between 2 and 8 min (claims 4-6) or between 4 and 5 min (claims 7-9); to heat treatment under the influence of an electric field.

It would have been obvious to one of ordinary skill in the art at the time of the invention to have subjected the cell to heat treatment for between 2 and 8 minutes (claim 4-6) or between 4 and 5 minutes (claims 7-9) since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F. 2d 272,205 USPQ 215 (CCPA 1980), especially in light of the fact that the time scale used during experimentation is of the same order of magnitude (min) as seen in Sentein (Figure 6) and as seen in Zhao (10 min) (experimental, ¶ 1).

Regarding claim 12, Cravino and Sentein are silent to heating above a glass transition temperature of the electron donor.

Zhao teaches heating above a glass transition temperature of the electron donor (conjugated polymer) (Results section, ¶ 1).

It would have been obvious to one of ordinary skill in the art at the time of the invention to increase the heating temperature to above the T_g of the conjugated polymer as taught by Zhao because an enhanced crystallization of the polymer can be obtained, as taught by Zhao (Results section, ¶ 4), along with this enhanced crystallization comes increases in hole mobility as seen by the supporting evidence provided by Dittmer (page 1273, ¶ 1).

Regarding claim 13, the reference teaches that the electric field is formed by applying a field voltage to the first and second electrodes (Sentien: section 2, ¶ 3).

Regarding claim 14, the reference teaches that the electric field exceeds a no-load voltage of the photovoltaic cell (Sentien: section 5, ¶ 1). Where 5 to 10 V clearly exceeds a no-load voltage because the open current voltage of single junction cells are typically of the order of 1 V or less.

Regarding claims 15 and 22, the reference teaches that the electric field exceeds the no-load voltage by at least 1 V (Sentien: section 5, ¶ 1). Where 5 to 10 V clearly exceeds a no-load voltage.

Regarding claim 16, Sentein suggests application of a field voltage between 2.5 and 3 V.

It would have been obvious to one of ordinary skill in the art at the time of the invention to apply a voltage between 2.5 and 3 V, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F. 2d 272,205 USPQ 215 (CCPA 1980), especially in light of

the fact that the current/voltage experiments were performed for a broad range of values as seen in Sentein (Figure 5).

Regarding claims 17-18, Sentein and Zhao teache that the photovoltaic cell is subjected for between 2 and 8 min (claim 17) or between 4 and 5 min (claims 18); to heat treatment under the influence of an electric field.

It would have been obvious to one of ordinary skill in the art at the time of the invention to have subjected the cell to heat treatment for between 2 and 8 minutes (claim 17) or between 4 and 5 minutes (claim 18) since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F. 2d 272,205 USPQ 215 (CCPA 1980), especially in light of the fact that the time scale used during experimentation is of the same order of magnitude (min) as seen in Sentein (Figure 6) and as seen in Zhao (10 min) (experimental, ¶ 1).

Regarding claim 20, Cravino teaches that the photoactive layer comprises an electron donor and an electron acceptor (section 2, ¶ 1).

Regarding claim 22, Cravino teaches that the electric field exceeds the no-load voltage by at least 1 V (Sentien: section 5, ¶ 1). Where 5 to 10 V clearly exceeds a no-load voltage.

Regarding claim 23, Sentein teaches that the photovoltaic cell is subjected for between 4 and 5 min (claim 23); to heat treatment under the influence of an electric field.

It would have been obvious to one of ordinary skill in the art at the time of the invention to have subjected the cell to heat treatment for between 4 and 5 minutes

(claim 23) since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F. 2d 272,205 USPQ 215 (CCPA 1980), especially in light of the fact that the time scale used during experimentation is of the same order of magnitude (min) as seen in Sentein (Figure 6) and as seen in Zhao (10 min) (experimental, ¶ 1).

(10) Response to Argument

Claim 1

Appellant argues that the rejections are based on an odd hodgepodge of references put together in a fashion that is blatantly based on hindsight rationale. In response to Appellant's argument that the Examiner's conclusion of obviousness is based upon improper hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the Appellant's disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971).

Appellant argues that at least one reference has been misinterpreted and misapplied, however does not disclose the reference nor the misunderstanding at the moment.

Appellant argues that the Examiner makes assertions of fact without appropriate evidence to support the assertions, however, the Examiner has not taken official notice at any point during prosecution.

Appellant argues that the Examiner's rejections are based on a misunderstanding of the claimed subject matter, subject matter disclosed in the references cited, misunderstanding of basic concepts of US patent law, and basic aspects of USPTO procedure. In response to Appellant's allegations, the Examiner believes to have responded to Appellants arguments as well as having clearly outlined the rejection as seen above.

Appellant argues that one of ordinary skill in the art would not understand the term "extended delocalized π-electron source" and that a fullerene posses such an electron system. The Examiner notes that the terminology and its link to fullerenes was discussed in the first office action filed 4/16/2008 and was not contested. The Examiner does not consider the statement a statement of official notice because the Cravino reference uses the terminology, "extended delocali[z]ed π-electron" (section 1, first sentence). Moreover, fullerenes are a compound comprising an extended network of 60 benzene rings. Benzene rings are made up of delocalized π-electrons (π -bonds) meaning that the electrons are shared among the 6 carbons in each benzene ring. These facts are well known in the art. Should the word "source" have led to any confusion the Examiner notes that because fullerenes possess such an extended delocalized π-electron system they provide a source of electrons which pass through the fullerene phase (Cravino: section 1, ¶ 2, bullet 2). Had Appellant considered the statement to be official notice, according to the MPEP 2144.03 B., Appellant did not make the argument so as to adequately traverse the finding, by specifically pointing out

the errors in the action including a statement as to why the fact is not considered common knowledge or well known in the art.

Appellant argues that there is no evidence for the assertion that use of materials such as fullerenes would lead to cost effective fabrication of flexible large area solar cells. The Examiner disagrees. Both Cravino and Sentein discuss such a benefit being the result of polymeric semiconductor materials which are known to include conjugated polymers and fullerenes. Cravino states that “since the discovery of a photoinduced electron transfer from nondegenerate ground state conjugated polymers to fullerenes, these materials are considered for the cost effective fabrication of flexible large area solar cells and photodectectors,” (Cravino: section 1, ¶ 1, last sentence). Sentein states that polymeric semiconductor devices are receiving increasing attention in view of potential applications requiring low cost processing over large areas”(Sentein: section 1, ¶ 1, first sentence).

Appellant argues that the Examiner has misunderstood the Sentein reference. The Examiner disagrees. Sentein is relied upon as a teaching that it is known in the art to use an electrical field and a heat treatment to achieve orientation and rectification in polymeric materials used in the solar cell art (title, abstract and section 1, ¶ 1). Sentein teaches that creating a p-n junction between two organic semiconductors is also known in the art (section 1, ¶ 1). The Examiner agrees with Appellant that the specific analysis of Sentein is towards a push-pull diode molecule. Although Sentein focuses the paper on a specific push-pull diode molecule, a molecule having both p and n (anode and cathode) components unified in one macromolecule, the Examiner notes that the

abstract and conclusion generalize the findings to orientation within polymeric semiconductor materials, to which fullerene and conjugated polymers belong (Sentein: section 5, ¶ 1). It would have been obvious to one of ordinary skill in the art to apply the electric current and heat treatment of Sentein in Cravino because the electric current and heat treatment provide rectification which reduces potential barriers for charge injection and extraction especially in light of the fact that Cravino acknowledges the use of rectification in the art (section 1, ¶ 2) and explores solutions to the previous shortcomings associated with rectification (clustering), one solution being a tethered or grafted or double cable macromolecule, a molecule that has both p and n (donor and acceptor) components unified in one macromolecule (section 1, ¶ s 2 and 3). Furthermore, the Examiner would like to emphasize the similarities between the solution of Cravino, tethered polymer, and the novel junction of Sentein, push-pull diode like molecule. Again, it would have been obvious to one of ordinary skill in the art at the time of the invention to try combining rectification using the electrical and heat treatments of Sentein and tethered polymers, arguably taught by both Cravino and Sentein, in order to reduce the clustering effects and improve donor/acceptor interfacial area.

Appellant argues that one of ordinary skill in the art would not understand the term “tethered polymer of two different components”. As discussed in the previous paragraph, Cravino teaches the use of grafted or tethered or double cable polymers (a polymer with a backbone comprised of for example a p-type group and grafted or tethered to it a n-type polymer such as a fullerene) (section 1, ¶ 3, first sentence) as a

solution to clustering which reduces effective donor/acceptor interfacial area (section 1, ¶ s 2 and 3). As discussed above the Examiner would like to emphasize the similarities between the solution of Cravino, tethered polymer, and the novel junction of Sentein, push-pull diode like molecule.

Appellant argues that Sentein does not remedy Cravino in the requirement by claim 1 that the fullerene is a compound different from the conjugated polymer. First and foremost the Sentein reference is not relied upon for this purpose. Additionally, the Examiner believes the limitation can be read in two distinct manners. First, the tethered polymer of Cravino which comprises a fullerene component and a conjugated polymer backbone component has two difference compounds, wherein the fullerene and the conjugated polymer are not one and the same. In the first situation, should the fullerene and the conjugated polymers both be fullerenes they would not read on the limitation as the conjugated polymer and the fullerene would not be different compounds. Second, should the limitation be read to require that "a compound different from" is only achieved when there is not a covalent bond linking the components the Examiner reminds Appellant that Sentein is *not* relied on for this limitation. Gebeyehu teaches the use of a conjugated polymer and a fullerene as separate nonbonded compounds in composites for solar cells (abstract). Gebeyehu teaches the importance of bicontinuous networks in order to achieve high conversion efficiency (section 1, ¶ 2). Again, Cravino acknowledges the importance of preventing clustering by increasing donor/acceptor interfacial area which can be achieved by a bicontinuous interpenetrating network wherein one, by all means not the only, elegant solution is a tethered polymer (section

1, ¶ 3). Gebeyehu reinforces the notion that the electric field and heat treatment of Sentein could be used in a conjugated polymer and fullerene system such as that found in Cravino because Gebeyehu states that conjugated polymers and fullerenes are favorably tuned by electric field (section 2, ¶ 3). Moreover, Cravino, Sentein and Appellant teach that two separate unbonded compounds is well known in the solar art (Cravino: section 1, ¶s 1 and 2, Sentein: section 1, ¶ 1, and the instant specification: page 3, "State of the Art", third sentence).

Appellant argues that the rectification methods (electric field and heat treatment) of Sentein do not translate to conjugated polymer and fullerene systems because Sentein teaches rectification in certain polymers and Appellant references the title of Sentein. However, the title of Sentein is generalized and does not recite particular polymers, nor do the abstract and conclusion. Moreover, as discussed above, Gebeyehu reinforces that an electric field may be used to favorably tune conjugated polymers and fullerenes (section 2, ¶ 3). Again, the Examiner has used Sentein as a general teaching that use of an electric field and heat treatment rectifies and orients polymeric material. Despite the use of Sentein as a general teaching, the Examiner has also pointed out numerous similarities between the references and will briefly reiterate them: both Cravino and Sentein discuss the benefits of rectification, both discuss the use of tethered/push-pull compounds and both teach that it is well known in the solar art to use separate unbonded compounds. Appellant goes on to argue that because the molecule of Sentein is a polar molecule with a dipole moment while that or Cravino posses a p and n-type materials the references would not have been obvious to

combine. In addition to the discussed similarities above, the Examiner reiterates that a diode molecule, a molecule having both p and n (anode and cathode) and is therefore from the same field of study. One of ordinary skill would appreciate that polar molecules (molecules with a net charge, region of extra or devoid of electrons), diode molecules a molecule having both p and n (anode – electron abundant and cathode – electron deficient), and p/n molecules (molecules which are electron abundant and deficient, respectively) all have in one form or another a net charge which enables control via an electric field. Once more, Sentein is relied upon as a general teaching and Gebeyehu reinforces that an electric field favorably tunes both conjugated polymers and fullerenes.

Appellant asserts that the Examiner has been responding to arguments of non-analogous art. The Examiner agrees. For example, the Examiner has interpreted arguments such as Sentein is directed towards a specific type of polymer different from that of Cravino such that the references can not be combined, as an argument of non-analogous art. The Examiner apologizes if response to such arguments under the heading of non-analogous art has led to any confusion. Each argument has been independently addressed above without such a heading.

Appellant argues that the Examiner misunderstands the Sentein reference. The Examiner has outlined the Sentein reference and how it has been applied above. In summary, Sentein is relied upon for the general teaching that polymeric materials can be rectified and oriented under an electric field and heat treatment (title and abstract).

Appellant argues that the Examiner has not pointed out where Zhao teaches that increasing temperature increases crystallization of the conjugated polymer. The Examiner disagrees. In each rejection the Examiner has placed the section and paragraph corresponding to the Zhao reference. Zhao establishes that crystallinity is a result effective variable dependent on temperature. Zhao goes on to teach that the slow process of crystallization occurs at most temperatures above the glass transition temperature (T_g) (Zhao: Results Section, ¶ 5). Dittmer was relied upon as supporting evidence that conjugated polymer/fullerene systems which undergo a heat treatment thereby increasing crystallinity via the slow process leads to overall enhancement through increased hole mobility (Dittmer: page 1273, left column, ¶ 1). Therefore, Zhao and Dittmer support the notion presented by both Cravino and Sentein that increased crystallinity (rectification) leads to overall enhancement wherein the increased crystallinity is achieved by a heat treatment above the T_g of the conjugated polymer. Moreover, one of ordinary skill in the art would appreciate that increasing temperature increases molecular mobility enabling molecules to easily move, orient and rectify as compared to motion at low temperatures (where the extreme can be seen by the motion in a gas as opposed to in a solid). As a result, it would have been obvious to one of ordinary skill in the art to use the heating temperature above the T_g of Zhao supported by Dittmer in modified Cravino because the slow process of crystallization occurs at most temperatures above the glass transition temperature (T_g) (Zhao: Results Section, ¶ 5) especially since Dittmer teaches that conjugated polymer/fullerene systems are

enhanced by a heat treatment which increases crystallinity via the slow process (Dittmer: page 1273, left column, ¶ 1).

Appellant argues that the Gebeyehu reference is misplaced because the title refers to conjugated polymer/fullerene composites. The Examiner disagrees. A composite is a material made from two significantly physically or chemically different materials in order to take advantage of both materials properties. The Examiner has relied on Gebeyehu because the reference teaches the use of the two different compounds required by claim 1 (conjugated polymer and fullerene) as separate nonbonded materials.

Appellant argues that because the electric field of Gebeyehu is applied during the use of the photovoltaic cell and thus the reference would not have been obvious to use in the combination provided. The Examiner disagrees. Firstly, the Examiner has not relied on Gebeyehu for the limitation regarding the electric field treatment. The Examiner would appreciate it if Appellant would refrain from attacking the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Furthermore, the Examiner notes that the instant method is a post treatment, and asserts that the application of an electric field while the solar cell is in use reads on a post-treatment. Finally, as discussed before, the Gebeyehu reference when discussed by the Examiner in relation to the electric field is merely cited to reinforce that one of ordinary skill in the art would have appreciated that an electric

field can tune conjugated polymers and fullerenes, as taught by Gebeyehu (section 2, ¶ 3).

Appellant argues that Sentein does not teach using a field voltage that exceeds a no-load voltage. The Examiner has asserted that Sentein uses a field voltage that exceeds a no-load voltage since the first office action dated 4/16/2008. To the Examiner's knowledge this is the first argument made by Appellant that Sentein does not teach using a field voltage that exceeds a no-load voltage. Sentein teaches applying an electric field for rectification purposes. Sentein clearly shows application of a voltage (V) to the polymeric material and the orientation/rectification effects (Sentein: Figure 4 at (V ≈100 V/μm); section 3, ¶ 2 and Figure 5 which provides a range of voltages up to 20V). Given the broadest reasonable interpretation the Examiner notes that exceeding a no-load voltage simply requires that more than zero voltage is applied. Appellant has not explained how the voltages of Sentein applied do not meet the requirement. Guidelines regarding the applied voltage are found on page 4 of the instant specification and state that a voltage above 1V wherein between 2.5 and 3V is favorable. As pointed out, the voltages used by Sentein exceed the no-load voltage requirements of the instant claimed invention and therefore read on the claims.

<u>Claim 2</u>

In addition to the response to arguments regarding claim 1, the Examiner is not persuaded by arguments pertaining to claim 2. Appellant argues that there is no teaching in Sentein that the no-load voltage exceeds at least 1 V. The Examiner has asserted that Sentein uses a field voltage that exceeds a no-load voltage since the first

office action dated 4/16/2008. To the Examiner's knowledge this is the first argument made by Appellant that Sentein does not teach using a field voltage that exceeds a no-load voltage. Sentein teaches applying an electric field for rectification purposes. Sentein clearly shows application of a voltage (V) to the polymeric material and the orientation/rectification effects (Sentein: Figure 4 at (V ≈100 V/μm); section 3, ¶ 2 and Figure 5 which provides a range of voltages up to 20V). Given the broadest reasonable interpretation the Examiner notes that exceeding a no-load voltage simply requires that more than zero voltage is applied. Appellant has not explained how the voltages of Sentein applied do not meet the requirement.

Claim 3

In addition to the response to arguments regarding claim 2, the Examiner is not persuaded by arguments pertaining to claim 3. Appellant argues that there is no teaching in Sentein that the no-load voltage between 2.5 and 3 V. The Examiner is not convinced by Appellant's arguments that one of ordinary skill in the art would not posses the skill to determine the optimum value. Sentein teaches that there is a relationship (result effective variable) between voltage and molecular order (Figure 7). Because Sentein is relied generally for a teaching that application of an electric field leads to rectification in polymeric material, one of ordinary skill in the art would have found it obvious at the time of the invention to determine the optimum value of voltage for a given system.

Claims 4-6

In addition to the response to arguments regarding claims 1-3, the Examiner is not persuaded by arguments pertaining to claims 4-6. Appellant argues that the Examiner has misapplied *Boesch*, the Examiner disagrees. The Examiner has established that time and voltage are result effective variables, effecting the molecular orientation. It would have been obvious to one of ordinary skill in the art to experimentally determine the optimum value of each to maximize orientation and overall enhancement of the device, as discussed above.

Claims 7-9

In addition to the response to arguments regarding claims 1-3, the Examiner is not persuaded by arguments pertaining to claims 7-9. Appellant argues that the Examiner has misapplied *Boesch*, the Examiner disagrees. The Examiner has established that time and voltage are result effective variables, effecting the molecular orientation. It would have been obvious to one of ordinary skill in the art to experimentally determine the optimum value of each to maximize orientation and overall enhancement of the device, as discussed above.

Claim 10

Appellant argues that the rejections are based on an odd hodgepodge of references put together in a fashion that is blatantly based on hindsight rationale. In response to Appellant's argument that the examiner's conclusion of obviousness is based upon improper hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of

ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the Appellant's disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971).

Appellant argues that at least one reference has been misinterpreted and misapplied, however does not disclose the reference nor the misunderstanding.

Appellant argues that the Examiner makes assertions of fact without appropriate evidence to support the assertions, however, the Examiner has not taken official notice at any point during prosecution.

Appellant argues that the Examiner's rejections are based on a misunderstanding of the claimed subject matter, subject matter disclosed in the references cited, misunderstanding of basic concepts of US patent law, and basic aspects of USPTO procedure. In response to Appellant's allegations, the Examiner believes to have responded to Appellants arguments as well as having clearly outlined the rejection as seen above.

Appellant argues that one of ordinary skill in the art would not understand the term "extended delocalized π-electron source" and that a fullerene posses such an electron system. The Examiner notes that the terminology and its link to fullerenes was discussed in the first office action filed 4/16/2008. The Examiner does not consider the statement a statement of official notice because the Cravino reference uses the terminology, "extended delocali[z]ed π-electron" (section 1, first sentence). Moreover, fullerenes are a compound comprising an extended network of 60 benzene rings. Benzene rings are made up of delocalized π-electrons (bonds) meaning that the

electrons are shared among the 6 carbons in each benzene ring. Should the word "source" have led to any confusion the Examiner notes that because fullerenes posses such an extended delocalized π-electron system they provide a source of electrons which pass through the fullerene phase (Cravino: section 1, ¶ 2, bullet 2). Had Appellant considered the statement to be official notice, according to the MPEP 2144.03 B., Appellant did not make the argument so as to adequately traverse the finding, by specifically pointing out the errors in the action including a statement as to why the fact is not considered common knowledge or well known in the art.

Appellant argues that there is no evidence for the assertion that use of materials such as fullerenes would lead to cost effective fabrication of flexible large area solar cells. The Examiner disagrees. Both Cravino and Sentein discuss such a benefit being the result of polymeric semiconductor materials which are known to include conjugated polymers and fullerenes (Cravino: section 1, ¶ 1, last sentence and Sentein: section 1, ¶ 1, first sentence).

Appellant argues that the Examiner has misunderstood the Sentein reference. The Examiner disagrees. Sentein is relied upon as a teaching that it is known in the art to use an electrical field and a heat treatment to achieve orientation and rectification in polymeric materials used in the solar cell art (title, abstract and section 1, ¶ 1). Sentein teaches that creating a p-n junction between two organic semiconductors is known in the art (section 1, ¶ 1). The Examiner agrees with Appellant that the specific analysis of Sentein is towards a push-pull diode molecule. Although Sentein focuses the paper on a specific push-pull diode molecule, a molecule having both p and n (anode and

cathode) components unified in one macromolecule, the Examiner notes that the conclusion generalizes the findings to orientation within polymeric semiconductor materials, to which fullerene and conjugated polymers belong (Sentein: section 5, ¶ 1). It would have been obvious to one of ordinary skill in the art to apply the electric current and heat treatment of Sentein in Cravino because the electric current and heat treatment provide rectification which reduces potential barriers for charge injection and extraction especially in light of the fact that Cravino acknowledges the use of rectification in the art (section 1, ¶ 2) and explores solutions to the previous shortcomings associated with rectification (clustering), one solution being a tethered or grafted or double cable macromolecule, a molecule that has both p and n (donor and acceptor) components unified in one macromolecule (section 1, ¶ s 2 and 3). Furthermore, the Examiner would like to emphasize the similarities between the solution of Cravino, tethered polymer, and the novel junction of Sentein, push-pull diode like molecule. Again, it would have been obvious to one of ordinary skill in the art at the time of the invention to try combining rectification using the electrical and heat treatments of Sentein and tethered polymers, arguably taught by both Cravino and Sentein, in order to reduce the clustering effects and improve donor/acceptor interfacial area.

Appellant argues that one of ordinary skill in the art would not understand the term “tethered polymer of two different components”. As discussed in the previous paragraph, Cravino teaches the use of grafted or tethered or double cable polymers (a polymer with a backbone comprised of for example a p-type group and grafted or

tethered to it a n-type polymer such as a fullerene) (section 1, ¶ 3, first sentence) as a solution to clustering which reduces effective donor/acceptor interfacial area (section 1, ¶ s 2 and 3). As discussed above the Examiner would like to emphasize the similarities between the solution of Cravino, tethered polymer, and the novel junction of Sentein, push-pull diode like molecule.

Appellant argues that Sentein does not remedy Cravino in the requirement by claim 1 that the fullerene is a compound different from the conjugated polymer. The Examiner believes the limitation can be read in two distinct manners. First, the tethered polymer of Cravino which comprises a fullerene component and a conjugated polymer backbone component has two difference compounds, wherein the fullerene and the conjugated polymer are not one and the same. In the first situation, should the fullerene and the conjugated polymers by fullerenes they would not read on the limitation as the conjugated polymer and the fullerene would not be different compounds. Second, should the limitation be read to require that "a compound different from" is only achieved when there is not a covalent bond linking the components the Examiner notes that Sentein is *not* relied on for this limitation. Gebeyehu teaches the use of a conjugated polymer and a fullerene as separate nonbonded compounds in composites for solar cells (abstract). Gebeyehu teaches the importance of bicontinuous networks in order to achieve high conversion efficiency (section 1, ¶ 2). Again, Cravino acknowledges the importance of preventing clustering by increasing donor/acceptor interfacial area which can be achieved by a bicontinuous interpenetrating network wherein one, by all means not the only, elegant solution is a tethered polymer (section

1, ¶ 3). Gebeyehu reinforces the notion that the electric field and heat treatment of Sentein could be used in a conjugated polymer and fullerene system such as that found in Cravino because Gebeyehu states that conjugated polymers and fullerenes are favorably tuned by electric field (section 2, ¶ 3). Moreover, Cravino, Sentein and Appellant teach that two separate unbonded compounds is well known in the solar art (Cravino: section 1, ¶s 1 and 2, Sentein: section 1, ¶ 1, and the instant specification: page 3, "State of the Art", third sentence).

Appellant argues that the rectification methods (electric field and heat treatment) of Sentein to not translate to conjugated polymer and fullerene systems because Sentein teaches rectification in certain polymers and Appellant references the title of Sentein. However, the title of Sentein is generalized and does not recite particular polymers, nor do the abstract and conclusion. Moreover, as discussed above, Gebeyehu reinforces that an electric field may be used to favorably tune conjugated polymers and fullerenes (section 2, ¶ 3). Again, the Examiner has used Sentein as a general teaching that use of an electric field and heat treatment rectifies and orients polymeric material. Despite the use of Sentein as a general teaching, the Examiner has also pointed out numerous similarities between the references and will briefly reiterate them: both Cravino and Sentein discuss the benefits of rectification, both discuss the use of tethered/push-pull compounds and both teach that it is well known in the solar art to use separate unbonded compounds. Appellant goes on to argue that because the molecule of Sentein is a polar molecule with a dipole moment while that or Cravino posses a p and n-type materials the references would not have been obvious to

combine. In addition to the discussed similarities above, the Examiner reiterates that a diode molecule, a molecule having both p and n (anode and cathode) and is therefore from the same field of study. One of ordinary skill would appreciate that polar molecules (molecules with a net charge, region of extra or devoid of electrons), diode molecules a molecule having both p and n (anode – electron abundant and cathode – electron deficient), and p/n molecules (molecules which are electron abundant and deficient, respectively) all have in one form or another a net charge which enables control via an electric field. Once more, Sentein is relied upon as a general teaching and Gebeyehu reinforces that an electric field favorably tunes both conjugated polymers and fullerenes.

Appellant asserts that the Examiner has been responding to arguments of non-analogous art. The Examiner agrees. For example, the Examiner has interpreted arguments such as Sentein is directed towards a specific type of polymer different from that of Cravino such that the references can not be combined, as an argument of non-analogous art. The Examiner apologizes if response to such arguments under the heading of non-analogous art has led to any confusion. Each argument has been independently addressed above without a heading.

Appellant argues that the Examiner misunderstands the Sentein reference. The Examiner has outlined the Sentein reference and how it has been applied above. In summary, Sentein is relied upon for the general teaching that polymeric materials can be rectified and oriented under an electric field and heat treatment (title and abstract).

Appellant argues that the Gebeyehu reference is misplaced because the title refers to conjugated polymer/fullerene composites. The Examiner disagrees. A composite is a material made from two significantly physically or chemically different materials in order to take advantage of both materials properties. The Examiner has relied on Gebeyehu because the reference teaches the use of the two different compounds required by claim 1 (conjugated polymer and fullerene) as separate nonbonded materials.

Appellant argues that because the electric field of Gebeyehu is applied during the use of the photovoltaic cell and thus the reference would not have been obvious to use in the combination provided. The Examiner disagrees. Firstly, the Examiner has not relied on Gebeyehu for the limitation regarding the electric field treatment. The Examiner would appreciate it if Appellant would refrain from attacking the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Furthermore, the Examiner notes that the instant method is a post treatment, and asserts that the application of an electric field while the solar cell is in use reads on a post-treatment. Finally, as discussed before, the Gebeyehu reference when discussed by the Examiner in relation to the electric field is merely cited to reinforce that one of ordinary skill in the art would have appreciated that an electric field can tune conjugated polymers and fullerenes, as taught by Gebeyehu (section 2, ¶ 3).

Appellant argues that Sentein does not teach using a field voltage that exceeds a no-load voltage. The Examiner has asserted that Sentein uses a field voltage that exceeds a no-load voltage since the first office action dated 4/16/2008. To the Examiner's knowledge this is the first argument made by Appellant that Sentein does not teach using a field voltage that exceeds a no-load voltage. Sentein teaches applying an electric field for rectification purposes. Sentein clearly shows application of a voltage (V) to the polymeric material and the orientation/rectification effects (Sentein: Figure 4 at (V ≈100 V/μm); section 3, ¶ 2 and Figure 5 which provides a range of voltages up to 20V). Given the broadest reasonable interpretation the Examiner notes that exceeding a no-load voltage simply requires that more than zero voltage is applied. Appellant has not explained how the voltages of Sentein applied do not meet the requirement. Guidelines regarding the applied voltage are found on page 4 of the instant specification and state that a voltage above 1V wherein between 2.5 and 3V is favorable. As pointed out, the voltages used by Sentein exceed the no-load voltage requirements of the instant claimed invention and therefore read on the claims.

Claim 12

In addition to the response to arguments regarding claim 10, the Examiner is not persuaded by arguments pertaining to claim 12. Appellant argues that the Examiner has not pointed out where Zhao teaches that increasing temperature increases crystallization of the conjugated polymer. The Examiner disagrees. The Examiner points to the results section paragraph three in the rejection. Zhao therefore establishes that crystallinity is a result effective variable dependent on temperature. Zhao goes on

to teach that the slow process of crystallization occurs at most temperatures above the glass transition temperature (T_g) (Zhao: Results Section, ¶ 5). Dittmer was relied upon as supporting evidence that conjugated polymer/fullerene systems which undergo a heat treatment thereby increasing crystallinity via the slow process leads to overall enhancement through increased hole mobility (Dittmer: page 1273, left column, ¶ 1). Therefore, Zhao and Dittmer support the notion presented by both Cravino and Sentein that increased crystallinity (rectification) leads to overall enhancement wherein the increased crystallinity is achieved by a heat treatment above the T_g of the conjugated polymer. Moreover, one of ordinary skill in the art would appreciate that increasing temperature increases molecular mobility enabling molecules to easily move, orient and rectify as compared to motion at low temperatures (where the extreme is seen as motion in a gas as opposed to a solid). As a result, it would have been obvious to one of ordinary skill in the art to use the heating temperature above the T_g of Zhao supported by Dittmer in modified Cravino because the slow process of crystallization occurs at most temperatures above the glass transition temperature (T_g) (Zhao: Results Section, ¶ 5) especially since Dittmer teaches that conjugated polymer/fullerene systems are enhanced by a heat treatment which increases crystallinity via the slow process (Dittmer: page 1273, left column, ¶ 1).

Claim 13

In addition to the response to arguments regarding claim 10, the Examiner is not persuaded by arguments pertaining to claim 13. Appellant argues that there is no teaching in Sentein that a voltage is applied. Sentein clearly shows application of a

voltage (V) to the polymeric material and the orientation/rectification effects (Sentein: Figure 4 at (V ≈100 V/μm); section 3, ¶ 2 and Figure 5 which provides a range of voltages up to 20V).

Claim 14

In addition to the response to arguments regarding claim 13, the Examiner is not persuaded by arguments pertaining to claim 14. Appellant argues that there is no teaching in Sentein that a no-load voltage is applied. The Examiner has asserted that Sentein uses a field voltage that exceeds a no-load voltage since the first office action dated 4/16/2008. To the Examiner's knowledge this is the first argument made by Appellant that Sentein does not teach using a field voltage that exceeds a no-load voltage. Sentein teaches applying an electric field for rectification purposes. Sentein clearly shows application of a voltage (V) to the polymeric material and the orientation/rectification effects (Sentein: Figure 4 at (V ≈100 V/μm); section 3, ¶ 2 and Figure 5 which provides a range of voltages up to 20V). Given the broadest reasonable interpretation the Examiner notes that exceeding a no-load voltage simply requires that more than zero voltage is applied. Appellant has not explained how the voltages of Sentein applied do not meet the requirement.

Claim 15

In addition to the response to arguments regarding claim 13, the Examiner is not persuaded by arguments pertaining to claim 15. Appellant argues that there is no teaching in Sentein that the no-load voltage exceeds at least 1 V. The Examiner has asserted that Sentein uses a field voltage that exceeds a no-load voltage since the first

office action dated 4/16/2008. To the Examiner's knowledge this is the first argument made by Appellant that Sentein does not teach using a field voltage that exceeds a no-load voltage. Sentein teaches applying an electric field for rectification purposes. Sentein clearly shows application of a voltage (V) to the polymeric material and the orientation/rectification effects (Sentein: Figure 4 at (V ≈100 V/μm); section 3, ¶ 2 and Figure 5 which provides a range of voltages up to 20V). Given the broadest reasonable interpretation the Examiner notes that exceeding a no-load voltage simply requires that more than zero voltage is applied. Appellant has not explained how the voltages of Sentein applied do not meet the requirement.

Claim 16

In addition to the response to arguments regarding claim 13, the Examiner is not persuaded by arguments pertaining to claim 16. Appellant argues that there is no teaching in Sentein that the no-load voltage between 2.5 and 3 V. The Examiner is not convinced by Appellant’s arguments that one of ordinary skill in the art would not posses the skill to determine the optimum value. Sentein teaches that there is a relationship (result effective variable) between voltage and molecular order (Figure 7). Because Sentein is relied generally for a teaching that application of an electric field leads to rectification in polymeric material, one of ordinary skill in the art would have found it obvious at the time of the invention to determine the optimum value of voltage for a given system.

Claims 17-18

In addition to the response to arguments regarding claim 13, the Examiner is not persuaded by arguments pertaining to claims 17-18. Appellant argues that the Examiner has misapplied *Boesch*, the Examiner disagrees. The Examiner has established that time and voltage are result effective variables, effecting the molecular orientation. It would have been obvious to one of ordinary skill in the art to experimentally determine the optimum value of each to maximize orientation and overall enhancement of the device, as discussed above.

<u>Claim 19</u>

Appellant argues that the rejections are based on an odd hodgepodge of references put together in a fashion that is blatantly based on hindsight rationale. In response to Appellant's argument that the Examiner's conclusion of obviousness is based upon improper hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the Appellant's disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971).

Appellant argues that at least one reference has been misinterpreted and misapplied, however does not disclose the reference nor the misunderstanding at the moment.

Appellant argues that the Examiner makes assertions of fact without appropriate evidence to support the assertions, however, the Examiner has not taken official notice at any point during prosecution.

Appellant argues that the Examiner's rejections are based on a misunderstanding of the claimed subject matter, subject matter disclosed in the references cited, misunderstanding of basic concepts of US patent law, and basic aspects of USPTO procedure. In response to Appellant's allegations, the Examiner believes to have responded to Appellants arguments as well as having clearly outlined the rejection as seen above.

Appellant argues that one of ordinary skill in the art would not understand the term "extended delocalized π-electron source" and that a fullerene posses such an electron system. The Examiner notes that the terminology and its link to fullerenes was discussed in the first office action filed 4/16/2008 and was not contested. The Examiner does not consider the statement a statement of official notice because the Cravino reference uses the terminology, "extended delocali[z]ed π-electron" (section 1, first sentence). Moreover, fullerenes are a compound comprising an extended network of 60 benzene rings. Benzene rings are made up of delocalized π-electrons (π -bonds) meaning that the electrons are shared among the 6 carbons in each benzene ring. These facts are well known in the art. Should the word "source" have led to any confusion the Examiner notes that because fullerenes posses such an extended delocalized π-electron system they provide a source of electrons which pass through the fullerene phase (Cravino: section 1, ¶ 2, bullet 2). Had Appellant considered the

statement to be official notice, according to the MPEP 2144.03 B., Appellant did not make the argument so as to adequately traverse the finding, by specifically pointing out the errors in the action including a statement as to why the fact is not considered common knowledge or well known in the art.

Appellant argues that there is no evidence for the assertion that use of materials such as fullerenes would lead to cost effective fabrication of flexible large area solar cells. The Examiner disagrees. Both Cravino and Sentein discuss such a benefit being the result of polymeric semiconductor materials which are known to include conjugated polymers and fullerenes (Cravino: section 1, ¶ 1, last sentence and Sentein: section 1, ¶ 1, first sentence).

Appellant argues that the Examiner has misunderstood the Sentein reference. The Examiner disagrees. Sentein is relied upon as a teaching that it is known in the art to use an electrical field and a heat treatment to achieve orientation and rectification in polymeric materials used in the solar cell art (title, abstract and section 1, ¶ 1). Sentein teaches that creating a p-n junction between two organic semiconductors is also known in the art (section 1, ¶ 1). The Examiner agrees with Appellant that the specific analysis of Sentein is towards a push-pull diode molecule. Although Sentein focuses the paper on a specific push-pull diode molecule, a molecule having both p and n (anode and cathode) components unified in one macromolecule, the Examiner notes that the abstract and conclusion generalize the findings to orientation within polymeric semiconductor materials, to which fullerene and conjugated polymers belong (Sentein: section 5, ¶ 1). It would have been obvious to one of ordinary skill in the art to apply the

electric current and heat treatment of Sentein in Cravino because the electric current and heat treatment provide rectification which reduces potential barriers for charge injection and extraction especially in light of the fact that Cravino acknowledges the use of rectification in the art (section 1, ¶ 2) and explores solutions to the previous shortcomings associated with rectification (clustering), one solution being a tethered or grafted or double cable macromolecule, a molecule that has both p and n (donor and acceptor) components unified in one macromolecule (section 1, ¶ s 2 and 3). Furthermore, the Examiner would like to emphasize the similarities between the solution of Cravino, tethered polymer, and the novel junction of Sentein, push-pull diode like molecule. Again, it would have been obvious to one of ordinary skill in the art at the time of the invention to try combining rectification using the electrical and heat treatments of Sentein and tethered polymers, arguably taught by both Cravino and Sentein, in order to reduce the clustering effects and improve donor/acceptor interfacial area.

Appellant argues that one of ordinary skill in the art would not understand the term “tethered polymer of two different components”. As discussed in the previous paragraph, Cravino teaches the use of grafted or tethered or double cable polymers (a polymer with a backbone comprised of for example a p-type group and grafted or tethered to it a n-type polymer such as a fullerene) (section 1, ¶ 3, first sentence) as a solution to clustering which reduces effective donor/acceptor interfacial area (section 1, ¶ s 2 and 3). As discussed above the Examiner would like to emphasize the similarities

between the solution of Cravino, tethered polymer, and the novel junction of Sentein, push-pull diode like molecule.

Appellant argues that Sentein does not remedy Cravino in the requirement by claim 1 that the fullerene is a compound different from the conjugated polymer. First and foremost the Sentein reference is not relied upon for this purpose. Additionally, the Examiner believes the limitation can be read in two distinct manners. First, the tethered polymer of Cravino which comprises a fullerene component and a conjugated polymer backbone component has two difference compounds, wherein the fullerene and the conjugated polymer are not one and the same. In the first situation, should the fullerene and the conjugated polymers both be fullerenes they would not read on the limitation as the conjugated polymer and the fullerene would not be different compounds. Second, should the limitation be read to require that "a compound different from" is only achieved when there is not a covalent bond linking the components the Examiner reminds Appellant that Sentein is *not* relied on for this limitation. Gebeyehu teaches the use of a conjugated polymer and a fullerene as separate nonbonded compounds in composites for solar cells (abstract). Gebeyehu teaches the importance of bicontinuous networks in order to achieve high conversion efficiency (section 1, ¶ 2). Again, Cravino acknowledges the importance of preventing clustering by increasing donor/acceptor interfacial area which can be achieved by a bicontinuous interpenetrating network wherein one, by all means not the only, elegant solution is a tethered polymer (section 1, ¶ 3). Gebeyehu reinforces the notion that the electric field and heat treatment of Sentein could be used in a conjugated polymer and fullerene system such as that found

in Cravino because Gebeyehu states that conjugated polymers and fullerenes are favorably tuned by electric field (section 2, ¶ 3). Moreover, Cravino, Sentein and Appellant teach that two separate unbonded compounds is well known in the solar art (Cravino: section 1, ¶s 1 and 2, Sentein: section 1, ¶ 1, and the instant specification: page 3, "State of the Art", third sentence).

Appellant argues that the rectification methods (electric field and heat treatment) of Sentein do not translate to conjugated polymer and fullerene systems because Sentein teaches rectification in certain polymers and Appellant references the title of Sentein. However, the title of Sentein is generalized and does not recite particular polymers, nor do the abstract and conclusion. Moreover, as discussed above, Gebeyehu reinforces that an electric field may be used to favorably tune conjugated polymers and fullerenes (section 2, ¶ 3). Again, the Examiner has used Sentein as a general teaching that use of an electric field and heat treatment rectifies and orients polymeric material. Despite the use of Sentein as a general teaching, the Examiner has also pointed out numerous similarities between the references and will briefly reiterate them: both Cravino and Sentein discuss the benefits of rectification, both discuss the use of tethered/push-pull compounds and both teach that it is well known in the solar art to use separate unbonded compounds. Appellant goes on to argue that because the molecule of Sentein is a polar molecule with a dipole moment while that or Cravino posses a p and n-type materials the references would not have been obvious to combine. In addition to the discussed similarities above, the Examiner reiterates that a diode molecule, a molecule having both p and n (anode and cathode) and is therefore

from the same field of study. One of ordinary skill would appreciate that polar molecules (molecules with a net charge, region of extra or devoid of electrons), diode molecules a molecule having both p and n (anode – electron abundant and cathode – electron deficient), and p/n molecules (molecules which are electron abundant and deficient, respectively) all have in one form or another a net charge which enables control via an electric field. Once more, Sentein is relied upon as a general teaching and Gebeyehu reinforces that an electric field favorably tunes both conjugated polymers and fullerenes.

Appellant asserts that the Examiner has been responding to arguments of non-analogous art. The Examiner agrees. For example, the Examiner has interpreted arguments such as Sentein is directed towards a specific type of polymer different from that of Cravino such that the references can not be combined, as an argument of non-analogous art. The Examiner apologizes if response to such arguments under the heading of non-analogous art has led to any confusion. Each argument has been independently addressed above without such a heading.

Appellant argues that the Examiner misunderstands the Sentein reference. The Examiner has outlined the Sentein reference and how it has been applied above. In summary, Sentein is relied upon for the general teaching that polymeric materials can be rectified and oriented under an electric field and heat treatment (title and abstract).

Appellant argues that the Examiner has not pointed out where Zhao teaches that increasing temperature increases crystallization of the conjugated polymer. The Examiner disagrees. The Examiner points to the results section paragraph three in the

rejection. Zhao establishes that crystallinity is a result effective variable dependent on temperature. Zhao goes on to teach that the slow process of crystallization occurs at most temperatures above the glass transition temperature (T_g) (Zhao: Results Section, ¶ 5). Dittmer was relied upon as supporting evidence that conjugated polymer/fullerene systems which undergo a heat treatment thereby increasing crystallinity via the slow process leads to overall enhancement through increased hole mobility (Dittmer: page 1273, left column, ¶ 1). Therefore, Zhao and Dittmer support the notion presented by both Cravino and Sentein that increased crystallinity (rectification) leads to overall enhancement wherein the increased crystallinity is achieved by a heat treatment above the T_g of the conjugated polymer. Moreover, one of ordinary skill in the art would appreciate that increasing temperature increases molecular mobility enabling molecules to easily move, orient and rectify as compared to motion at low temperatures (where the extreme can be seen by the motion in a gas as opposed to in a solid). As a result, it would have been obvious to one of ordinary skill in the art to use the heating temperature above the T_g of Zhao supported by Dittmer in modified Cravino because the slow process of crystallization occurs at most temperatures above the glass transition temperature (T_g) (Zhao: Results Section, ¶ 5) especially since Dittmer teaches that conjugated polymer/fullerene systems are enhanced by a heat treatment which increases crystallinity via the slow process (Dittmer: page 1273, left column, ¶ 1).

Appellant argues that the Gebeyehu reference is misplaced because the title refers to conjugated polymer/fullerene composites. The Examiner disagrees. A composite is a material made from two significantly physically or chemically different

materials in order to take advantage of both materials properties. The Examiner has relied on Gebeyehu because the reference teaches the use of the two different compounds required by claim 1 (conjugated polymer and fullerene) as separate nonbonded materials.

Appellant argues that because the electric field of Gebeyehu is applied during the use of the photovoltaic cell and thus the reference would not have been obvious to use in the combination provided. The Examiner disagrees. Firstly, the Examiner has not relied on Gebeyehu for the limitation regarding the electric field treatment. The Examiner would appreciate it if Appellant would refrain from attacking the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Furthermore, the Examiner notes that the instant method is a post treatment, and asserts that the application of an electric field while the solar cell is in use reads on a post-treatment. Finally, as discussed before, the Gebeyehu reference when discussed by the Examiner in relation to the electric field is merely cited to reinforce that one of ordinary skill in the art would have appreciated that an electric field can tune conjugated polymers and fullerenes, as taught by Gebeyehu (section 2, ¶ 3).

Appellant argues that Sentein does not teach using a field voltage that exceeds a no-load voltage. The Examiner has asserted that Sentein uses a field voltage that exceeds a no-load voltage since the first office action dated 4/16/2008. To the

Examiner's knowledge this is the first argument made by Appellant that Sentein does not teach using a field voltage that exceeds a no-load voltage. Sentein teaches applying an electric field for rectification purposes. Sentein clearly shows application of a voltage (V) to the polymeric material and the orientation/rectification effects (Sentein: Figure 4 at (V ≈100 V/μm); section 3, ¶ 2 and Figure 5 which provides a range of voltages up to 20V). Given the broadest reasonable interpretation the Examiner notes that exceeding a no-load voltage simply requires that more than zero voltage is applied. Appellant has not explained how the voltages of Sentein applied do not meet the requirement. Guidelines regarding the applied voltage are found on page 4 of the instant specification and state that a voltage above 1V wherein between 2.5 and 3V is favorable. As pointed out, the voltages used by Sentein exceed the no-load voltage requirements of the instant claimed invention and therefore read on the claims.

Appellant argues that the Examiner has misapplied *Boesch*, the Examiner disagrees. The Examiner has established that time and voltage are result effective variables, effecting the molecular orientation. It would have been obvious to one of ordinary skill in the art to experimentally determine the optimum value of each to maximize orientation and overall enhancement of the device, as discussed above.

<u>Claim 22</u>

In addition to the response to arguments regarding claim 19, the Examiner is not persuaded by arguments pertaining to claim 22. Appellant argues that there is no teaching in Sentein that the no-load voltage exceeds at least 1 V. The Examiner has asserted that Sentein uses a field voltage that exceeds a no-load voltage since the first

office action dated 4/16/2008. To the Examiner's knowledge this is the first argument made by Appellant that Sentein does not teach using a field voltage that exceeds a no-load voltage. Sentein teaches applying an electric field for rectification purposes. Sentein clearly shows application of a voltage (V) to the polymeric material and the orientation/rectification effects (Sentein: Figure 4 at (V ≈100 V/μm); section 3, ¶ 2 and Figure 5 which provides a range of voltages up to 20V). Given the broadest reasonable interpretation the Examiner notes that exceeding a no-load voltage simply requires that more than zero voltage is applied. Appellant has not explained how the voltages of Sentein applied do not meet the requirement.

<u>Claim 23</u>

In addition to the response to arguments regarding claim 19, the Examiner is not persuaded by arguments pertaining to claim 23. Appellant argues that the Examiner has misapplied *Boesch*, the Examiner disagrees. The Examiner has established that time and voltage are result effective variables, effecting the molecular orientation. It would have been obvious to one of ordinary skill in the art to experimentally determine the optimum value of each to maximize orientation and overall enhancement of the device, as discussed above.

<u>Claim 24</u>

Appellant argues that the rejections are based on an odd hodgepodge of references put together in a fashion that is blatantly based on hindsight rationale. In response to Appellant's argument that the Examiner's conclusion of obviousness is based upon improper hindsight reasoning, it must be recognized that any judgment on

obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the Appellant's disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971).

Appellant argues that at least one reference has been misinterpreted and misapplied, however does not disclose the reference nor the misunderstanding at the moment.

Appellant argues that the Examiner makes assertions of fact without appropriate evidence to support the assertions, however, the Examiner has not taken official notice at any point during prosecution.

Appellant argues that the Examiner's rejections are based on a misunderstanding of the claimed subject matter, subject matter disclosed in the references cited, misunderstanding of basic concepts of US patent law, and basic aspects of USPTO procedure. In response to Appellant’s allegations, the Examiner believes to have responded to Appellants arguments as well as having clearly outlined the rejection as seen above.

Appellant argues that one of ordinary skill in the art would not understand the term “extended delocalized π-electron source” and that a fullerene posses such an electron system. The Examiner notes that the terminology and its link to fullerenes was discussed in the first office action filed 4/16/2008 and was not contested. The Examiner does not consider the statement a statement of official notice because the Cravino

reference uses the terminology, “extended delocali[z]ed π-electron” (section 1, first sentence). Moreover, fullerenes are a compound comprising an extended network of 60 benzene rings. Benzene rings are made up of delocalized π-electrons (π -bonds) meaning that the electrons are shared among the 6 carbons in each benzene ring. These facts are well known in the art. Should the word “source” have led to any confusion the Examiner notes that because fullerenes posses such an extended delocalized π-electron system they provide a source of electrons which pass through the fullerene phase (Cravino: section 1, ¶ 2, bullet 2). Had Appellant considered the statement to be official notice, according to the MPEP 2144.03 B., Appellant did not make the argument so as to adequately traverse the finding, by specifically pointing out the errors in the action including a statement as to why the fact is not considered common knowledge or well known in the art.

Appellant argues that there is no evidence for the assertion that use of materials such as fullerenes would lead to cost effective fabrication of flexible large area solar cells. The Examiner disagrees. Both Cravino and Sentein discuss such a benefit being the result of polymeric semiconductor materials which are known to include conjugated polymers and fullerenes (Cravino: section 1, ¶ 1, last sentence and Sentein: section 1, ¶ 1, first sentence).

Appellant argues that the Examiner has misunderstood the Sentein reference. The Examiner disagrees. Sentein is relied upon as a teaching that it is known in the art to use an electrical field and a heat treatment to achieve orientation and rectification in polymeric materials used in the solar cell art (title, abstract and section 1, ¶ 1). Sentein

teaches that creating a p-n junction between two organic semiconductors is also known in the art (section 1, ¶ 1). The Examiner agrees with Appellant that the specific analysis of Sentein is towards a push-pull diode molecule. Although Sentein focuses the paper on a specific push-pull diode molecule, a molecule having both p and n (anode and cathode) components unified in one macromolecule, the Examiner notes that the abstract and conclusion generalize the findings to orientation within polymeric semiconductor materials, to which fullerene and conjugated polymers belong (Sentein: section 5, ¶ 1). It would have been obvious to one of ordinary skill in the art to apply the electric current and heat treatment of Sentein in Cravino because the electric current and heat treatment provide rectification which reduces potential barriers for charge injection and extraction especially in light of the fact that Cravino acknowledges the use of rectification in the art (section 1, ¶ 2) and explores solutions to the previous shortcomings associated with rectification (clustering), one solution being a tethered or grafted or double cable macromolecule, a molecule that has both p and n (donor and acceptor) components unified in one macromolecule (section 1, ¶ s 2 and 3). Furthermore, the Examiner would like to emphasize the similarities between the solution of Cravino, tethered polymer, and the novel junction of Sentein, push-pull diode like molecule. Again, it would have been obvious to one of ordinary skill in the art at the time of the invention to try combining rectification using the electrical and heat treatments of Sentein and tethered polymers, arguably taught by both Cravino and Sentein, in order to reduce the clustering effects and improve donor/acceptor interfacial area.

Appellant argues that one of ordinary skill in the art would not understand the term “tethered polymer of two different components”. As discussed in the previous paragraph, Cravino teaches the use of grafted or tethered or double cable polymers (a polymer with a backbone comprised of for example a p-type group and grafted or tethered to it a n-type polymer such as a fullerene) (section 1, ¶ 3, first sentence) as a solution to clustering which reduces effective donor/acceptor interfacial area (section 1, ¶ s 2 and 3). As discussed above the Examiner would like to emphasize the similarities between the solution of Cravino, tethered polymer, and the novel junction of Sentein, push-pull diode like molecule.

Appellant argues that Sentein does not remedy Cravino in the requirement by claim 1 that the fullerene is a compound different from the conjugated polymer. First and foremost the Sentein reference is not relied upon for this purpose. Additionally, the Examiner believes the limitation can be read in two distinct manners. First, the tethered polymer of Cravino which comprises a fullerene component and a conjugated polymer backbone component has two difference compounds, wherein the fullerene and the conjugated polymer are not one and the same. In the first situation, should the fullerene and the conjugated polymers both be fullerenes they would not read on the limitation as the conjugated polymer and the fullerene would not be different compounds. Second, should the limitation be read to require that "a compound different from" is only achieved when there is not a covalent bond linking the components the Examiner reminds Appellant that Sentein is *not* relied on for this limitation. Gebeyehu teaches the use of a conjugated polymer and a fullerene as separate nonbonded compounds in

composites for solar cells (abstract). Gebeyehu teaches the importance of bicontinuous networks in order to achieve high conversion efficiency (section 1, ¶ 2). Again, Cravino acknowledges the importance of preventing clustering by increasing donor/acceptor interfacial area which can be achieved by a bicontinuous interpenetrating network wherein one, by all means not the only, elegant solution is a tethered polymer (section 1, ¶ 3). Gebeyehu reinforces the notion that the electric field and heat treatment of Sentein could be used in a conjugated polymer and fullerene system such as that found in Cravino because Gebeyehu states that conjugated polymers and fullerenes are favorably tuned by electric field (section 2, ¶ 3). Moreover, Cravino, Sentein and Appellant teach that two separate unbonded compounds is well known in the solar art (Cravino: section 1, ¶s 1 and 2, Sentein: section 1, ¶ 1, and the instant specification: page 3, "State of the Art", third sentence).

Appellant argues that the rectification methods (electric field and heat treatment) of Sentein do not translate to conjugated polymer and fullerene systems because Sentein teaches rectification in certain polymers and Appellant references the title of Sentein. However, the title of Sentein is generalized and does not recite particular polymers, nor do the abstract and conclusion. Moreover, as discussed above, Gebeyehu reinforces that an electric field may be used to favorably tune conjugated polymers and fullerenes (section 2, ¶ 3). Again, the Examiner has used Sentein as a general teaching that use of an electric field and heat treatment rectifies and orients polymeric material. Despite the use of Sentein as a general teaching, the Examiner has also pointed out numerous similarities between the references and will briefly reiterate

them: both Cravino and Sentein discuss the benefits of rectification, both discuss the use of tethered/push-pull compounds and both teach that it is well known in the solar art to use separate unbonded compounds. Appellant goes on to argue that because the molecule of Sentein is a polar molecule with a dipole moment while that or Cravino posses a p and n-type materials the references would not have been obvious to combine. In addition to the discussed similarities above, the Examiner reiterates that a diode molecule, a molecule having both p and n (anode and cathode) and is therefore from the same field of study. One of ordinary skill would appreciate that polar molecules (molecules with a net charge, region of extra or devoid of electrons), diode molecules a molecule having both p and n (anode – electron abundant and cathode – electron deficient), and p/n molecules (molecules which are electron abundant and deficient, respectively) all have in one form or another a net charge which enables control via an electric field. Once more, Sentein is relied upon as a general teaching and Gebeyehu reinforces that an electric field favorably tunes both conjugated polymers and fullerenes.

Appellant asserts that the Examiner has been responding to arguments of non-analogous art. The Examiner agrees. For example, the Examiner has interpreted arguments such as Sentein is directed towards a specific type of polymer different from that of Cravino such that the references can not be combined, as an argument of non-analogous art. The Examiner apologizes if response to such arguments under the heading of non-analogous art has led to any confusion. Each argument has been independently addressed above without such a heading.

Appellant argues that the Examiner misunderstands the Sentein reference. The Examiner has outlined the Sentein reference and how it has been applied above. In summary, Sentein is relied upon for the general teaching that polymeric materials can be rectified and oriented under an electric field and heat treatment (title and abstract).

Appellant argues that the Examiner has not pointed out where Zhao teaches that increasing temperature increases crystallization of the conjugated polymer. The Examiner disagrees. The Examiner points to the results section paragraph three in the rejection. Zhao establishes that crystallinity is a result effective variable dependent on temperature. Zhao goes on to teach that the slow process of crystallization occurs at most temperatures above the glass transition temperature (T_g) (Zhao: Results Section, ¶ 5). Dittmer was relied upon as supporting evidence that conjugated polymer/fullerene systems which undergo a heat treatment thereby increasing crystallinity via the slow process leads to overall enhancement through increased hole mobility (Dittmer: page 1273, left column, ¶ 1). Therefore, Zhao and Dittmer support the notion presented by both Cravino and Sentein that increased crystallinity (rectification) leads to overall enhancement wherein the increased crystallinity is achieved by a heat treatment above the T_g of the conjugated polymer. Moreover, one of ordinary skill in the art would appreciate that increasing temperature increases molecular mobility enabling molecules to easily move, orient and rectify as compared to motion at low temperatures (where the extreme can be seen by the motion in a gas as opposed to in a solid). As a result, it would have been obvious to one of ordinary skill in the art to use the heating temperature above the T_g of Zhao supported by Dittmer in modified Cravino because

the slow process of crystallization occurs at most temperatures above the glass transition temperature (T_g) (Zhao: Results Section, ¶ 5) especially since Dittmer teaches that conjugated polymer/fullerene systems are enhanced by a heat treatment which increases crystallinity via the slow process (Dittmer: page 1273, left column, ¶ 1).

Appellant argues that the Gebeyehu reference is misplaced because the title refers to conjugated polymer/fullerene composites. The Examiner disagrees. A composite is a material made from two significantly physically or chemically different materials in order to take advantage of both materials properties. The Examiner has relied on Gebeyehu because the reference teaches the use of the two different compounds required by claim 1 (conjugated polymer and fullerene) as separate nonbonded materials.

Appellant argues that because the electric field of Gebeyehu is applied during the use of the photovoltaic cell and thus the reference would not have been obvious to use in the combination provided. The Examiner disagrees. Firstly, the Examiner has not relied on Gebeyehu for the limitation regarding the electric field treatment. The Examiner would appreciate it if Appellant would refrain from attacking the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Furthermore, the Examiner notes that the instant method is a post treatment, and asserts that the application of an electric field while the solar cell is in use reads on a post-treatment. Finally, as discussed before, the Gebeyehu

reference when discussed by the Examiner in relation to the electric field is merely cited to reinforce that one of ordinary skill in the art would have appreciated that an electric field can tune conjugated polymers and fullerenes, as taught by Gebeyehu (section 2, ¶ 3).

Appellant argues that Sentein does not teach using a field voltage that exceeds a no-load voltage. The Examiner has asserted that Sentein uses a field voltage that exceeds a no-load voltage since the first office action dated 4/16/2008. To the Examiner's knowledge this is the first argument made by Appellant that Sentein does not teach using a field voltage that exceeds a no-load voltage. Sentein teaches applying an electric field for rectification purposes. Sentein clearly shows application of a voltage (V) to the polymeric material and the orientation/rectification effects (Sentein: Figure 4 at (V ≈100 V/μm); section 3, ¶ 2 and Figure 5 which provides a range of voltages up to 20V). Given the broadest reasonable interpretation the Examiner notes that exceeding a no-load voltage simply requires that more than zero voltage is applied. Appellant has not explained how the voltages of Sentein applied do not meet the requirement. Guidelines regarding the applied voltage are found on page 4 of the instant specification and state that a voltage above 1V wherein between 2.5 and 3V is favorable. As pointed out, the voltages used by Sentein exceed the no-load voltage requirements of the instant claimed invention and therefore read on the claims.

Appellant argues that the Examiner does not have support for asserting that charge carriers are injected into the cell as a result of applying a voltage to the cell. The Examiner notes that when a current (I, directly proportional to V) is applied

electrons (carriers) are injected and flow from the anode (p-type) to the cathode (n-type). Closing a circuit is well known to provide such a flow of electrons. Appellant does not explain otherwise in the specification nor in prior arguments. The Examiner has not been contested as to the validity of the statement as of the office action dated 8/14/2008; the first office action after claim 24 was added.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/M. B./

Examiner, Art Unit 1795

Conferees:

/Alexa D. Neckel/

Supervisory Patent Examiner, Art Unit 1795

/William Krynski/

Quality Assurance Specialist, TC 1700